

Claims

1. A system for performing Time Domain Reflectometry (TDR) using Gaussian pulses, the system comprising:

5 a computer, comprising a CPU and a memory, wherein the memory is operable to store one or more software programs for performing TDR, and wherein the CPU is operable to execute said one or more software programs;

a waveform generator operable to couple to the computer;

a digitizer operable to couple to the computer and the waveform generator;

10 wherein the waveform generator is further operable to generate a modulated Gaussian pulse and transmit the Gaussian pulse to the digitizer and a Device Under Test (DUT);

wherein the DUT is further operable to reflect at least a portion of the transmitted Gaussian pulse to the digitizer, and wherein said at least a portion of the transmitted
15 Gaussian pulse comprises one or more reflected Gaussian pulses;

wherein the digitizer is further operable to receive and digitize a signal comprising a plurality of Gaussian pulses, wherein the plurality of Gaussian pulses comprises the transmitted Gaussian pulse and the one or more reflected Gaussian pulses;

wherein the memory is further operable to store the digitized signal;

20 wherein the CPU is operable to execute the one or more software programs to detect and characterize the transmitted Gaussian pulse and the one or more reflected Gaussian pulses; and

wherein said detection and characterization of the transmitted Gaussian pulse and the one or more reflected Gaussian pulses is useable to perform TDR analysis on the
25 DUT.

2. The system of claim 1, wherein said CPU being operable to execute the one or more software programs to detect and characterize the transmitted Gaussian pulse

and the one or more reflected Gaussian pulses comprises said CPU being operable to execute the one or more software programs to perform:

determining an estimation of N parameters for each of the plurality of Gaussian pulses, wherein N is greater than or equal to one;

5 generating a plurality of permutations for each estimation of the N parameters, wherein the plurality of permutations comprises a corresponding plurality of parameter sets corresponding to a plurality of estimation waveforms;

generating a plurality of linear equations for each of the plurality of Gaussian pulses, wherein each linear equation is a function of a respective one of the parameter sets
10 and at least a subset of corresponding N parameter variables for each of the plurality of Gaussian pulses; and

determining the N parameter variables for each of the plurality of Gaussian pulses by solving the plurality of linear equations for each of the plurality of Gaussian pulses, wherein the determined parameters characterize the Gaussian pulse and the one or more
15 reflected Gaussian pulses.

3. The system of claim 2, wherein said generating the plurality of linear equations from the plurality of parameter sets comprises:

generating a plurality of closed form inner products, wherein each closed form
20 inner product is generated between the received signal and each estimation waveform; and

generating the plurality of linear equations from the plurality of inner products, wherein each linear equation is a function of a respective one of the plurality of parameter sets and corresponding N parameter variables.

25

4. The system of claim 2,

wherein said generating a plurality of permutations for each estimation of the N parameters comprises generating M permutations of each estimation of the N parameters,

and wherein the M permutations comprise M parameter sets corresponding to M estimation waveforms;

wherein said generating the plurality of linear equations for each of the plurality of Gaussian pulses comprises generating the plurality of linear equations from at least a
5 subset of the M parameter sets for each of the plurality of Gaussian pulses, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of a respective Gaussian pulse;

wherein said determining the N parameter variables for each of the plurality of Gaussian pulses comprises solving the respective plurality of linear equations for each of
10 the plurality of Gaussian pulses, wherein the determined parameters characterize the Gaussian pulse and the one or more reflected Gaussian pulses.

5. The system of claim 4,

wherein said generating the plurality of linear equations for each of the plurality of
15 Gaussian pulses comprises generating at least M linear equations from the M parameter sets for each of the plurality of Gaussian pulses.

6. The system of claim 2,

wherein said generating a plurality of permutations for each estimation of the N
20 parameters comprises generating M permutations of each estimation of the N parameters, and wherein the M permutations and the estimation comprise M+1 parameter sets corresponding to M+1 estimation waveforms for each of the plurality of Gaussian pulses;

wherein said generating a plurality of linear equations for each of the plurality of Gaussian pulses comprises generating M+1 linear equations from the M+1 parameter sets
25 for each of the plurality of Gaussian pulses, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of a respective Gaussian pulse;

wherein said determining the N parameter variables for each of the plurality of Gaussian pulses comprises solving the respective M+1 linear equations for each of the

plurality of Gaussian pulses, wherein the determined parameters characterize the Gaussian pulse and the one or more reflected Gaussian pulses.

7. The system of claim 6, wherein said generating $M+1$ linear equations from
5 the $M+1$ parameter sets comprises:

generating $M+1$ closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and

generating $M+1$ linear equations from the $M+1$ inner products, wherein each linear equation is a function of a respective one of the $M+1$ parameter sets and
10 corresponding N parameter variables of the respective Gaussian pulse.

8. The system of claim 6, and wherein M is greater than or equal to N , and wherein said determining the N parameter variables comprises overdetermining the N parameter variables of each of the plurality of Gaussian pulses by solving the $M+1$ linear
15 equations, wherein the respective overdetermined parameters characterize the Gaussian pulse and the one or more reflected Gaussian pulses.

9. The system of claim 6, wherein M is equal to $N-1$.

20 10. The system of claim 6, wherein M is equal to N .

11. The system of claim 2, wherein said determining the estimation of N parameters for each of the plurality of Gaussian pulses comprises, for each Gaussian pulse, performing:

25 a) determining a current area of interest of the received signal, wherein the current area of interest comprises a second sequence of values which includes at least a portion of the first sequence of values, and wherein the current area of interest comprises a start position and an end position;

b) selecting a current Gaussian window from a plurality of Gaussian windows, wherein the current Gaussian window comprises a third sequence of values representing a Gaussian waveform;

c) performing a windowed Fast Fourier Transform (FFT) using the selected Gaussian window and the determined area of interest to generate a power spectrum;

d) identifying a peak frequency amplitude from the power spectrum;

e) repeating a) through d) in an iterative manner until each of the plurality of Gaussian windows has been selected, generating a plurality of peak frequency amplitudes;

f) identifying a maximum peak frequency amplitude from said plurality of peak frequency amplitudes; and

g) selecting an estimation Gaussian window from the plurality of Gaussian windows corresponding to said identified maximum peak frequency amplitude, wherein said estimation of N parameters of the Gaussian pulse are determined from the estimation Gaussian window.

12. The system of claim 11, wherein said performing a windowed Fast Fourier Transform (FFT) using the selected Gaussian window and the determined area of interest comprises:

logically aligning the Gaussian window at the start position of the area of interest, wherein a sub-sequence of the values comprised in the area of interest aligns with the third sequence of values comprised in the Gaussian window;

performing an element-wise multiplication of the third sequence of values and the sub-sequence of values to generate a product waveform; and

applying a Discrete Fourier Transform to the product waveform to generate the power spectrum.

13. The system of claim 11, wherein the respective lengths of the second sequence of values and the third sequence of values are each a power of two.

14. The system of claim 11, wherein the length of the second sequence of values is twice the length of the third sequence of values.

5 15. The system of claim 2, wherein $N = 3$, and wherein the N parameters comprise inverse variance α_p , time shift t_p , and carrier frequency ω_t .

16. The system of claim 2, wherein the computer, the waveform generator, and the digitizer are each comprised on PXI cards in a PXI chassis, and wherein the system
10 comprises a PXI system.

17. The system of claim 2, wherein the DUT comprises one or more of a stand alone device, a PC board, an instrument, an electric or optical circuit, and an electric or optical transmission medium.
15

18. The system of claim 2, wherein said determined parameters characterizing the Gaussian pulse and the one or more reflected Gaussian pulses are useable to characterize a connection discontinuity in the DUT.

20 19. The system of claim 2, the system further comprising:
a display operable to couple to said computer, wherein the display is further operable to present visual information to a user; and
an Input/Output (I/O) interface operable to couple to said computer, wherein the I/O interface is further operable to communicate information with one or more external
25 devices.

20. The system of claim 19, wherein the computer, the waveform generator, and the digitizer are each comprised on PXI cards in a PXI chassis, wherein said display is comprised in the PXI chassis, and wherein the system comprises a PXI system.

21. The system of claim 19, wherein the computer, the waveform generator, the digitizer, and the I/O interface are each comprised on PXI cards in a PXI chassis, wherein said display is comprised in the PXI chassis, and wherein the system comprises a
5 PXI system.

22. The system of claim 19, wherein the computer, the waveform generator, the digitizer, the I/O interface, and a video card are each comprised on PXI cards in a PXI chassis, wherein the video card is operable to couple to the display, wherein said display
10 is external to the PXI chassis, and wherein the system comprises a PXI system.

23. The system of claim 1, wherein the CPU is operable to execute the one or more software programs to:

receive a digitized signal from an external source, wherein the digitized signal was
15 previously generated by a TDR system, wherein the signal comprises a plurality of Gaussian pulses including an initial modulated Gaussian pulse and one or more reflected modulated Gaussian pulses; and

detect and characterize the Gaussian pulse and the one or more reflected Gaussian pulses;

20 wherein said detection and characterization of the transmitted Gaussian pulse and the one or more reflected Gaussian pulses is useable to perform TDR analysis on the received digitized signal.

24. The system of claim 23, wherein said one or more reflected modulated
25 Gaussian pulses are produced by a second Device Under Test (DUT), and wherein said TDR analysis performed on the received digitized signal is useable to characterize interconnect discontinuities in the second DUT.

25. The system of claim 1, wherein said CPU being operable to execute the one or more software programs to detect and characterize the transmitted Gaussian pulse and the one or more reflected Gaussian pulses comprises said CPU being operable to execute the one or more software programs to perform:

- 5 determining an estimation of N parameters for each of the plurality of Gaussian pulses in the signal, wherein N is greater than or equal to one;
- generating M permutations of each estimation of the N parameters, wherein each of the M permutations comprises a representation of a corresponding permutation waveform, and wherein the M permutations and the estimation comprises M+1 parameter
- 10 sets corresponding to M+1 estimation waveforms;
- generating M+1 linear equations from the M+1 parameter sets for each of the plurality of Gaussian pulses, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables for each of the plurality of Gaussian pulses; and
- 15 determining the N parameter variables for each of the plurality of Gaussian pulses by solving the M+1 linear equations for each of the plurality of Gaussian pulses, wherein the determined parameters characterize the Gaussian pulse and the one or more reflected Gaussian pulses.

20 26. The system of claim 25, wherein said generating M+1 linear equations from the M+1 parameter sets comprises:

- generating M+1 closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and
- generating M+1 linear equations from the M+1 inner products, wherein each
- 25 linear equation is a function of a respective one of the M+1 parameter sets and corresponding N parameter variables.

27. The system of claim 25, wherein $M = N - 1$.

28. The system of claim 25, and wherein M is greater than or equal to N, and wherein said determining the N parameter variables comprises overdetermining the N parameter variables of each of the plurality of Gaussian pulses by solving the M+1 linear equations, wherein the respective overdetermined parameters characterize the Gaussian pulse and the one or more reflected Gaussian pulses.

29. A method for performing Time Domain Reflectometry (TDR) on a device under test (DUT) using Gaussian pulses, the method comprising:
receiving a signal, wherein the signal comprises a first sequence of values, and
10 wherein the signal comprises an initial modulated Gaussian pulse and one or more reflected modulated Gaussian pulses;
characterizing a first modulated Gaussian pulse in the signal;
subtracting the first modulated Gaussian pulse from the signal to produce a modified signal;
15 repeating said characterizing and said subtracting one or more times on the modified signal to characterize a plurality of modulated Gaussian pulses in the signal; and
analyzing the characterized Gaussian pulses to determine characteristics of the DUT.

20 30. The method of claim 29, wherein said characterizing a first modulated Gaussian pulse in the signal comprises:
generating a coarse estimate set of N parameters for the first modulated Gaussian pulse, wherein N is greater than or equal to one;
generating a plurality of permutations of the coarse estimate set of parameters,
25 wherein said plurality of permutations of the coarse estimate set comprises a plurality of parameter sets, and wherein each parameter set corresponds to an estimation waveform;
and

determining a refined set of N parameter values using the plurality of parameter sets, wherein the refined set of parameters characterizes the first modulated Gaussian pulse.

5 31. The method of claim 30,

 wherein said determining a refined set of N parameter values using the plurality of parameter sets comprises:

 generating a plurality of linear equations from the plurality of parameter sets, wherein each linear equation is a function of a respective one of the parameter sets and at
10 least a subset of the N parameter variables of the Gaussian pulse; and

 determining the N parameter variables of the Gaussian pulse by solving the plurality of linear equations, wherein the determined parameters characterize the Gaussian pulse.

15 32. The method of claim 31,

 wherein said generating a plurality of permutations comprises generating M permutations of the estimation of the N parameters, and wherein the M permutations comprise M parameter sets corresponding to M estimation waveforms;

 wherein said generating the plurality of linear equations comprises generating the
20 plurality of linear equations from at least a subset of the M parameter sets, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of the Gaussian pulse;

 wherein said determining the N parameter variables of the Gaussian pulse comprises solving the plurality of linear equations, wherein the determined parameters
25 characterize the Gaussian pulse.

 33. The method of claim 32,

 wherein said generating the plurality of linear equations comprises generating at least M linear equations from the M parameter sets.

34. The method of claim 31, wherein said generating the plurality of linear equations from the plurality of parameter sets comprises:

generating a plurality of closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and

generating the plurality of linear equations from the plurality of inner products, wherein each linear equation is a function of a respective one of the plurality of parameter sets and corresponding N parameter variables of the Gaussian pulse.

10

35. The method of claim 30,

wherein said generating a plurality of permutations comprises generating M permutations of the estimation of the N parameters, and wherein the M permutations and the estimation comprise M+1 parameter sets corresponding to M+1 estimation waveforms;

15

wherein said generating a plurality of linear equations comprises generating M+1 linear equations from the M+1 parameter sets, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of the Gaussian pulse;

20

wherein said determining the N parameter variables of the Gaussian pulse comprises solving the M+1 linear equations, wherein the determined parameters characterize the Gaussian pulse.

36. The method of claim 35, wherein said generating M+1 linear equations from the M+1 parameter sets comprises:

25

generating M+1 closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and

generating $M+1$ linear equations from the $M+1$ inner products, wherein each linear equation is a function of a respective one of the $M+1$ parameter sets and corresponding N parameter variables of the Gaussian pulse.

5 37. The method of claim 36, wherein $M = N - 1$.

38. The method of claim 35, wherein said determining a refined set of N parameter values using the plurality of parameter sets comprises:

10 generating $M+1$ linear equations from the $M+1$ parameter sets, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of the first modulated Gaussian pulse; and

 determining values of the N parameter variables by solving the $M+1$ linear equations, wherein the determined parameter variables characterize the first modulated Gaussian pulse.

15

39. The method of claim 38, wherein said generating $M+1$ linear equations from the parameter sets comprises:

 generating $M+1$ closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and

20 generating $M+1$ linear equations from the inner products, wherein each linear equation is a function of a respective one of the parameter sets and corresponding parameter variables of the first modulated Gaussian pulse.

40. The method of claim 38, wherein M is greater than or equal to N , and
25 wherein said determining the N parameter variables comprises overdetermining the N parameter variables of the Gaussian pulse by solving the $M+1$ linear equations, wherein the overdetermined parameters characterize the Gaussian pulse.

41. The method of claim 40, wherein $N = 3$, and wherein the N parameters comprise inverse variance α_p , time shift t_p , and carrier frequency ω_t .

42. The method of claim 40, wherein said generating a coarse estimate set of
5 N parameters for the first modulated Gaussian pulse comprises:

- a) determining a current area of interest of the received signal, wherein the current area of interest comprises a second sequence of values which includes at least a portion of the first sequence of values, and wherein the current area of interest comprises a start position and an end position;
- 10 b) selecting a current Gaussian window from a plurality of Gaussian windows, wherein the current Gaussian window comprises a third sequence of values representing a Gaussian waveform;
- c) performing a windowed Fast Fourier Transform (FFT) using the selected Gaussian window and the determined area of interest to generate a power spectrum;
- 15 d) identifying a peak frequency amplitude from the power spectrum;
- e) repeating a) through d) in an iterative manner until each of the plurality of Gaussian windows has been selected, generating a plurality of peak frequency amplitudes;
- f) identifying a maximum peak frequency amplitude from said plurality of
- 20 peak frequency amplitudes; and
- g) selecting an estimation Gaussian window from the plurality of Gaussian windows corresponding to said identified maximum peak frequency amplitude, wherein said coarse estimate set of N parameters of the Gaussian pulse is determined from the estimation Gaussian window.

25

43. The method of claim 42, wherein said performing a windowed Fast Fourier Transform (FFT) using the selected Gaussian window and the determined area of interest comprises:

logically aligning the Gaussian window at the start position of the area of interest, wherein a sub-sequence of the values comprised in the area of interest aligns with the third sequence of values comprised in the Gaussian window;

performing an element-wise multiplication of the third sequence of values and the
5 sub-sequence of values to generate a product waveform; and

applying a Discrete Fourier Transform to the product waveform to generate the power spectrum.

44. The method of claim 42, wherein the respective lengths of the second
10 sequence of values and the third sequence of values are each a power of two.

45. The method of claim 42, wherein the length of the second sequence of values is twice the length of the third sequence of values.

46. The method of claim 29, wherein said one or more reflected pulses are
15 generated by the Device Under Test (DUT) reflecting at least a portion of the initial modulated Gaussian pulse; and

wherein said determined parameters characterizing the Gaussian pulse and the one or more reflected Gaussian pulses are useable to characterize a connection discontinuity
20 in the DUT.

47. The method of claim 29, further comprising performing the following steps prior to said receiving the signal:

generating the initial modulated Gaussian pulse and transmitting the initial
25 modulated Gaussian pulse to a digitizer and the Device Under Test (DUT);

the DUT reflecting at least a portion of the transmitted Gaussian pulse to the digitizer in response to said transmitting, wherein said at least a portion of the transmitted Gaussian pulse comprises the one or more reflected Gaussian pulses; and

the digitizer receiving and digitizing the signal comprising the transmitted initial modulated Gaussian pulse and the one or more reflected Gaussian pulses in response to said reflecting.

5 48. The method of claim 47, further comprising storing the digitized signal in response to said receiving and digitizing.

 49. The method of claim 29, wherein said characterizing a first modulated Gaussian pulse in the signal comprises:
10 generating a coarse estimate set of N parameters for the first modulated Gaussian pulse, wherein N is greater than or equal to one;

 generating M permutations of the coarse estimate set of parameters, wherein M is greater than or equal to $N-1$, wherein said coarse estimate set and said M permutations of the coarse estimate set comprise $M+1$ parameter sets, and wherein each parameter set
15 corresponds to an estimation waveform; and

 determining a refined set of N parameter values using the $M+1$ parameter sets, wherein the refined set of parameters characterizes the first modulated Gaussian pulse.

 50. The method of claim 49, wherein said determining a refined set of N
20 parameter values using the $M+1$ parameter sets comprises:

 generating $M+1$ linear equations from the $M+1$ parameter sets, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of the first modulated Gaussian pulse; and

 determining values of the N parameter variables by solving the $M+1$ linear
25 equations, wherein the determined parameter variables characterize the first modulated Gaussian pulse.

 51. The method of claim 50, wherein said generating $M+1$ linear equations from the parameter sets comprises:

generating $M+1$ closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and

generating $M+1$ linear equations from the inner products, wherein each linear equation is a function of a respective one of the parameter sets and corresponding
5 parameter variables of the first modulated Gaussian pulse.

52. The method of claim 50, wherein M is greater than or equal to N , and wherein said determining the N parameter variables comprises overdetermining the N parameter variables of the Gaussian pulse by solving the $M+1$ linear equations, wherein
10 the overdetermined parameters characterize the Gaussian pulse.

53. A memory medium operable to store program instructions to analyze a signal, wherein the signal comprises a first sequence of values, and wherein the signal comprises an initial modulated Gaussian pulse and one or more reflected modulated
15 Gaussian pulses, wherein said program instructions are executable to perform:
characterizing a first modulated Gaussian pulse in the signal;
subtracting the first modulated Gaussian pulse from the signal to produce a modified signal;
repeating said characterizing and said subtracting one or more times on the
20 modified signal to characterize a plurality of modulated Gaussian pulses in the signal; and
analyzing the characterized Gaussian pulses to determine characteristics of a Device Under Test (DUT).

54. The memory medium of claim 53,
25 wherein said characterizing a first modulated Gaussian pulse in the signal comprises:
generating a coarse estimate set of N parameters for the first modulated Gaussian pulse, wherein N is greater than or equal to one;

generating a plurality of permutations of the coarse estimate set of parameters,
wherein said plurality of permutations of the coarse estimate set comprises a plurality of
parameter sets, and wherein each parameter set corresponds to an estimation waveform;
and

5 determining a refined set of N parameter values using the plurality of parameter
sets, wherein the refined set of parameters characterizes the first modulated Gaussian
pulse.

55. The memory medium of claim 54,
10 wherein said determining a refined set of N parameter values using the plurality of
parameter sets comprises:

generating a plurality of linear equations from the plurality of parameter sets,
wherein each linear equation is a function of a respective one of the parameter sets and at
least a subset of the N parameter variables of the Gaussian pulse; and
15 determining the N parameter variables of the Gaussian pulse by solving the
plurality of linear equations, wherein the determined parameters characterize the
Gaussian pulse.

56. The memory medium of claim 55,
20 wherein said generating a plurality of permutations comprises generating M
permutations of the estimation of the N parameters, and wherein the M permutations
comprise M parameter sets corresponding to M estimation waveforms;

wherein said generating the plurality of linear equations comprises generating the
plurality of linear equations from at least a subset of the M parameter sets, wherein each
25 linear equation is a function of a respective one of the parameter sets and corresponding
N parameter variables of the Gaussian pulse;

wherein said determining the N parameter variables of the Gaussian pulse
comprises solving the plurality of linear equations, wherein the determined parameters
characterize the Gaussian pulse.

57. The memory medium of claim 56,
wherein said generating the plurality of linear equations comprises generating at
least M linear equations from the M parameter sets.

5

58. The memory medium of claim 55, wherein said generating the plurality of
linear equations from the plurality of parameter sets comprises:

generating a plurality of closed form inner products, wherein each closed form
inner product is generated between the received signal and each estimation waveform;

10 and

generating the plurality of linear equations from the plurality of inner products,
wherein each linear equation is a function of a respective one of the plurality of parameter
sets and corresponding N parameter variables of the Gaussian pulse.

15

59. The memory medium of claim 54,

wherein said generating a plurality of permutations comprises generating M
permutations of the estimation of the N parameters, and wherein the M permutations and
the estimation comprise M+1 parameter sets corresponding to M+1 estimation
waveforms;

20

wherein said generating a plurality of linear equations comprises generating M+1
linear equations from the M+1 parameter sets, wherein each linear equation is a function
of a respective one of the parameter sets and corresponding N parameter variables of the
Gaussian pulse;

25

wherein said determining the N parameter variables of the Gaussian pulse
comprises solving the M+1 linear equations, wherein the determined parameters
characterize the Gaussian pulse.

60. The memory medium of claim 59, wherein said generating M+1 linear
equations from the M+1 parameter sets comprises:

generating M+1 closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and
generating M+1 linear equations from the M+1 inner products, wherein each linear equation is a function of a respective one of the M+1 parameter sets and
5 corresponding N parameter variables of the Gaussian pulse.

61. The memory medium of claim 60, wherein $M = N - 1$.

62. The memory medium of claim 59, wherein said determining a refined set
10 of N parameter values using the plurality of parameter sets comprises:

generating M+1 linear equations from the M+1 parameter sets, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of the first modulated Gaussian pulse; and

determining values of the N parameter variables by solving the M+1 linear
15 equations, wherein the determined parameter variables characterize the first modulated Gaussian pulse.

63. The memory medium of claim 62, wherein said generating M+1 linear equations from the parameter sets comprises:

20 generating M+1 closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and

generating M+1 linear equations from the inner products, wherein each linear equation is a function of a respective one of the parameter sets and corresponding parameter variables of the first modulated Gaussian pulse.

25

64. The memory medium of claim 62, wherein M is greater than or equal to N, and wherein said determining the N parameter variables comprises overdetermining the N parameter variables of the Gaussian pulse by solving the M+1 linear equations, wherein the overdetermined parameters characterize the Gaussian pulse.

65. The memory medium of claim 64, wherein $N = 3$, and wherein the N parameters comprise inverse variance α_p , time shift t_p , and carrier frequency ω_t .

- 5 66. The memory medium of claim 54, wherein said generating a coarse estimate set of N parameters for the first modulated Gaussian pulse comprises:
- a) determining a current area of interest of the received signal, wherein the current area of interest comprises a second sequence of values which includes at least a portion of the first sequence of values, and wherein the current area of interest comprises
10 a start position and an end position;
 - b) selecting a current Gaussian window from a plurality of Gaussian windows, wherein the current Gaussian window comprises a third sequence of values representing a Gaussian waveform;
 - c) performing a windowed Fast Fourier Transform (FFT) using the selected
15 Gaussian window and the determined area of interest to generate a power spectrum;
 - d) identifying a peak frequency amplitude from the power spectrum;
 - e) repeating a) through d) in an iterative manner until each of the plurality of Gaussian windows has been selected, generating a plurality of peak frequency amplitudes;
 - 20 f) identifying a maximum peak frequency amplitude from said plurality of peak frequency amplitudes; and
 - g) selecting an estimation Gaussian window from the plurality of Gaussian windows corresponding to said identified maximum peak frequency amplitude, wherein said coarse estimate set of N parameters of the Gaussian pulse is determined from the
25 estimation Gaussian window.

67. The memory medium of claim 66, wherein said performing a windowed Fast Fourier Transform (FFT) using the selected Gaussian window and the determined area of interest comprises:

logically aligning the Gaussian window at the start position of the area of interest, wherein a sub-sequence of the values comprised in the area of interest aligns with the third sequence of values comprised in the Gaussian window;

performing an element-wise multiplication of the third sequence of values and the
5 sub-sequence of values to generate a product waveform; and

applying a Discrete Fourier Transform to the product waveform to generate the power spectrum.

68. The memory medium of claim 66, wherein the respective lengths of the
10 second sequence of values and the third sequence of values are each a power of two.

69. The memory medium of claim 66, wherein the length of the second sequence of values is twice the length of the third sequence of values.

70. The memory medium of claim 53, wherein said one or more reflected
15 pulses are generated by the Device Under Test (DUT) reflecting at least a portion of the initial modulated Gaussian pulse; and

wherein said determined parameters characterizing the Gaussian pulse and the one or more reflected Gaussian pulses are useable to characterize a connection discontinuity
20 in the DUT.

71. The memory medium of claim 53, wherein, prior to said receiving the signal, said program instructions are executable to perform:

generating the initial modulated Gaussian pulse and transmitting the initial
25 modulated Gaussian pulse to a digitizer and the Device Under Test (DUT);

the DUT reflecting at least a portion of the transmitted Gaussian pulse to the digitizer in response to said transmitting, wherein said at least a portion of the transmitted Gaussian pulse comprises the one or more reflected Gaussian pulses; and

the digitizer receiving and digitizing the signal comprising the transmitted initial modulated Gaussian pulse and the one or more reflected Gaussian pulses in response to said reflecting.

5 72. The memory medium of claim 71, wherein said program instructions are further executable to perform:

 storing the digitized signal in response to said receiving and digitizing.

 73. The memory medium of claim 53, wherein said characterizing a first
10 modulated Gaussian pulse in the signal comprises:

 generating a coarse estimate set of N parameters for the first modulated Gaussian pulse, wherein N is greater than or equal to one;

 generating M permutations of the coarse estimate set of parameters, wherein M is greater than or equal to $N-1$, wherein said coarse estimate set and said M permutations of
15 the coarse estimate set comprise $M+1$ parameter sets, and wherein each parameter set corresponds to an estimation waveform; and

 determining a refined set of N parameter values using the $M+1$ parameter sets, wherein the refined set of parameters characterizes the first modulated Gaussian pulse.

20 74. The memory medium of claim 73, wherein said determining a refined set of N parameter values using the $M+1$ parameter sets comprises:

 generating $M+1$ linear equations from the $M+1$ parameter sets, wherein each linear equation is a function of a respective one of the parameter sets and corresponding N parameter variables of the first modulated Gaussian pulse; and

25 determining values of the N parameter variables by solving the $M+1$ linear equations, wherein the determined parameter variables characterize the first modulated Gaussian pulse.

75. The memory medium of claim 74, wherein said generating M+1 linear equations from the parameter sets comprises:

generating M+1 closed form inner products, wherein each closed form inner product is generated between the received signal and each estimation waveform; and

5 generating M+1 linear equations from the inner products, wherein each linear equation is a function of a respective one of the parameter sets and corresponding parameter variables of the first modulated Gaussian pulse.

76. The memory medium of claim 74, wherein M is greater than or equal to N,
10 and wherein said determining the N parameter variables comprises overdetermining the N parameter variables of the Gaussian pulse by solving the M+1 linear equations, wherein the overdetermined parameters characterize the Gaussian pulse.